killen, consisting of eighty-five vertebræ, with a spine situated above the fortieth from the anterior end, and with consequently forty-five vertebræ beyond it; this number would probably constitute nearly the whole of the caudal extremity, and is fewer by four only than in its living representative. In the specimen figured on plate vii. of the decade mentioned the spine extends above the fifteenth vertebra. In the one now being described the anterior dorsal spine is over the eighteenth or nineteenth vertebra; there can be no doubt, however, that its proper position must have been further back, because the fin to which it was attached is far behind the spine. From analogy it would be supposed that the spine occupied a position halfway between its present situation and that of the fin; and as this would place the spine above the twenty-second or twenty-third vertebra from the head, which is, as already indicated, the point inferred from the comparison with the recent fish, there remains little doubt that such was its actual position.

Locality. All the specimens hitherto described, including the one which is the subject of this paper, are from the Lias at Lyme Regis.

EXPLANATION OF PLATE XX.

Fig. 1. *Palæospinax priscus*, Egerton (nat. size).
Fig. 2. Dermal tubercles or shagreen on ventral fin (× 25).
Fig. 3. Ditto on ventral portion of body behind the ventral fin (× 25).
Fig. 4. Ditto on pectoral fin near the base of the anterior margin (× 25).

XLIV.—*On the originally Bilateral Character of the Renal Organ of Prosobranchia, and on the Homologies of the Yelk-sac of Cephalopoda.* By E. Ray Lankester, M.A., F.R.S., Jodrell Professor of Zoology in University College, London.

Two recent memoirs on molluscan morphology touch upon matters which have formed the subject of investigations by me, and which I have formerly discussed in the pages of this journal. I am therefore anxious to make a few remarks on the matters in question in the same place as that in which I first wrote of them.

I. Dr. J. W. Spengel, in a very interesting essay (Zeitschr. wiss. Zool. vol. xxxv.) entitled "Die Geruchsorgane und das Nervensystem der Mollusken," refers to a note by me "On some undescribed Points in the Anatomy of the Limpet (*Pa-*

tella vulgata)," published in the 'Annals' nearly fourteen years ago (vol. xx. 1867, p. 334). The organs which I there recognized as the "capito-pedal" orifices he now proposes to identify with olfactory organs. With regard to this, I have to say that I have long been aware that the "capito-pedal" pigmented bodies are not *orifices* blocked by pigmented excretion, as I at one time supposed; and I have no doubt, from the nerve-supply to this region, which was clearly figured by Prof. de Lacaze-Duthiers in vol. i. pl. iv. of his 'Archives de Zoologie expérimentale' (1872), and is now again figured by Dr. Spengel, that we have in the capito-pedal pigment-body a sense-organ, similar in character to the sense-organ described by Lacaze-Duthiers as existing in aquatic Pulmonate Gasteropoda (also in vol. i. of his Archives, "Du système nerveux des Mollusques Gastéropodes pulmonés aquatiques et d'un nouvel organe d'innervation"). This last memoir most unfortunately appears to have escaped Dr. Spengel's attention, who endeavours to identify the capito-pedal sense-organs of *Patella* with a rudimentary gill, and to bring under the same denomination the often plicated problematic sense-organs of a number of other Gasteropods.

In discussing these homologies Dr. Spengel is led to expound his views on the torsion of the visceral mass of the Prosobranch Gasteropods. His views are chiefly based upon the fact, first made known by me, of the existence of two renal organs in *Patella*. Dr. Jhering, in a memoir on the morphology of the renal organ of Mollusca (Zeitschr. für wiss. Zoologie, vol. xxix. 1877, p. 605), is the only observer who has confirmed my description of the existence of two renal organs in *Patella*; and he has added similar observations on *Fissurella* and *Haliotis*. Dr. Spengel, in reference to this matter, cites only the observations of Dr. Jhering, and omits all reference to the fact that I had discovered the condition of the renal organs of *Patella* ten years before that writer, although Dr. Jhering quotes my observations at full length. The fact has some importance; for, as a natural consequence of my observations, I have, during the period which has elapsed since they were made, been in the habit of teaching the same general views as to the torsion of the visceral mass of Gasteropoda and its effect upon the symmetry of the organs as are now advanced by Dr. Spengel (explained by a woodcut on p. 351 of his paper). This writer, to establish his views, makes use of the fact first observed by me, but erroneously (and, I do not doubt, unintentionally) attributes the observation to Dr. Jhering. Speaking of organs which are paired though not fully symmetrical in certain of the Prosobranchia, he says

"Dahin gehören in erster Linie die Kiemen und die Geruchsorgane, das Herz mit seinem zwei Vorhöfen und endlich nach den Beobachtungen v. Jherings die Nieren." Further, he discusses whether one of the "von v. Jhering beschriebenen Organe" may not be identical with the anal gland of *Murex*. I am not of the opinion that it is a reasonable thing to allow one's priority in such a matter to be handed by one writer to another without making any protest. Hence these few lines.

I may add that Dr. Jhering, in his memoir published in 1877, states that he was unable to find an opening leading from the pericardium into the renal organ as described by me. During April of this year I have, with the cooperation of my assistant Mr. A. G. Bourne, examined fresh limpets as to the pericardial orifice. Its presence can be demonstrated both by injections which pass from the pericardium, sometimes into the right, sometimes into the left renal sac, and by dissection. The orifice *leads directly into a narrow subanal tract of the further or right* renal sac, and not directly into the left or small renal sac, which, on account of its proximity, might have been expected to be the sac in communication with the pericardium. That the pericardial orifice should open directly into the *large*, or right, or infraanal renal organ of *Patella*, and not into the small one, is especially remarkable when we remember that it is the small renal sac which, lying dorsal and to the left of the rectum (in the primitive uncoiled condition of the visceral mass the small sac would obviously enough be to the right, and not to the left, of the rectum), would seem to correspond with the single renal sac of other Gasteropods.

II. Mr. W. K. Brooks has recently given an account, with figures, of the development of the Squid ('Anniversary Memoirs of the Boston Society of Natural History'), which, besides quotations from the writings of Kölliker, myself, and Bobretzky, contains sketches of the well-known surface-appearances exhibited by living specimens of *Loligo* at a few stages of its development. Mr. Brooks, however, is led to offer some reflections on the homologies of the arms, funnel, and yelk-sac of the embryo Cephalopod with parts of the adult Gasteropod. I cannot agree him when he says that he has "been so fortunate as to fill a gap by finding embryos which exhibit general molluscan characteristics;" and I can find nothing new in his comparison of the embryo Cephalopod with an embryo Pulmonate, excepting what I regard as erroneous. He is mistaken in quoting me as favouring a close comparison of the shell-gland discovered by me in Gastero-

pods and Lamellibranchs with the pen-sac of Cephalopoda, which I showed to originate, like the shell-gland, as an open invagination. I have been careful to point out reasons for doubting the exact equivalence of the two structures ("On the Development of the Pond-Snail, and on the early Stages of other Mollusca," Quart. Journ. Microsc. Sci. vol. xiv. 1874, p. 371).

Further, I cannot agree with Mr. Brooks in the view that the molluscan foot is necessarily an "unpaired" organ. It is truly enough a median organ; but it has necessarily a right and a left side, which in many cases tend to develop as two divergent lobes; and such growths as "epipodia" are only an expression of this tendency to bilateral development.

Mr. Brooks regards the arms of the Cephalopod and the funnel as either epipodial or as new and special organs of Cephalopods, whilst he advocates the view that the yelk-sac of Cephalopods represents the "median unpaired" foot of Mollusca, which has accordingly no representative in the adult Cephalopod.

Mr. Balfour, in his 'Comparative Embryology,' vol. i. p. 225, had anticipated Mr. Brooks's speculation as to the identity of the Cephalopod's yelk-sac with the Gasteropod's foot. He says:—"In Cephalopods the position of the Gasteropod foot is occupied by the external yolk-sack. In normal forms the blastopore closes at the apex of the yolk-sack, and at the two sides of the yolk-sack the arms grow out. These considerations seem to point to the conclusion that the normal Gasteropod foot is represented in the Cephalopod embryo by the yolk-sack, which has, owing to the immense bulk of food-yolk present in the ovum, become filled with food-yolk and enormously dilated."

I am unable to agree with the interpretation put upon the facts by Mr. Balfour and Mr. Brooks. I quite admit that the region in the Cephalopod distended by food-yelk is the axial region of the foot; that is obvious upon the first observation of the facts. But it is another thing to maintain that the projection or outgrowth *as such* represents the projection or outgrowth in its entirety known as *the* foot in Gasteropods. In my opinion it does not do so, but is a special embryonic dilatation of the axial region of the foot, and is no more representative of such an outgrowth as the adult muscular foot than is the very remarkable contractile sac on the foot of *Limax*.

Had Mr. Brooks compared his embryo squid with an embryo slug, he would, I think, have come nearer to making out the significance of the latter's yelk-sac than he has when comparing it to an embryo of an aquatic Pulmonate.

I was much struck by the remarkable structure and rhythmic pulsation of the sac on the foot of the embryo slug when I first studied it at Jena in 1871; and in the winter of the same year, when carrying on researches on the development of the Cephalopoda at Naples, I made the observation, first of all, that the wall of the yelk-sac of the embryo squid is rhythmically contractile, and, secondly, that the structure of that wall and its contractile elements is very closely similar to that of the contractile sac on the foot of the embryo *Limax*. I subjoin outline drawings of an embryo slug and an embryo squid, to render clear to those not familiar with these objects the position of the parts under discussion.

Fig. 1.

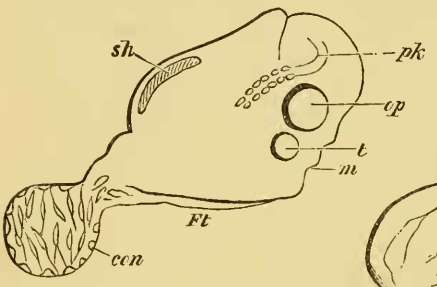

Fig. 2.

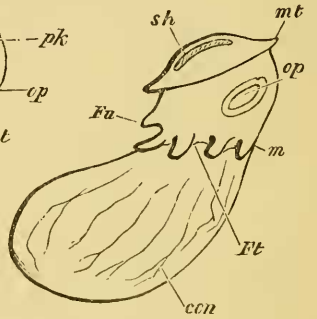

Fig. 1. Diagram of an embryo Slug.

Fig. 2. Diagram of an embryo Cephalopod. *m*, position of mouth; *Ft*, foot; *sh*, shell; *con*, contractile embryonic outgrowth of the pedal region (yelk-sac in Cephalopod); *op*, eye; *pk*, primitive kidney of slug; *t*, smaller head-tentacle of slug; *Fu*, funnel of Cephalopod; *mt*, mantle-flap of Cephalopod.

In a paper published in this magazine in February 1873 ("Zoological Observations made at Naples in the winter of 1871–72") I gave a brief outline of my results as to Cephalopod development, and I there said (p. 84):—"An interesting phenomenon is the contractility of the walls of the yelk-sac, which is observed at a very early period, as soon as the first rudiments of eyes, ears, and mouth have appeared. A rhythmic wave of contraction passes continually along the wall of the sac, at that part immediately in front of the alimentary tube, and doubtless acts so as to cause a circulation of nutrient material in the direction of the young embryo. The tissue which exhibits this contractility is of the same structure (stellate

cells) as that of the remarkable contractile vesicle observed in the pulmonate Gasteropoda, and which I have studied in *Limax*. It is probable that the two parts are homogenous."

So far as any comparison between the Cephalopod yelk-sac and the Gasteropod foot is legitimate, it appears to me that I had made it in the above passage some years since.

As to the homologies generally of Gasteropod and Cephalopod, I am inclined to agree with Mr. Brooks when he says "we cannot expect any valuable results to follow from the attempt to compare any part of the body of a Cephalopod with structures which, like the epipodial folds, are not common to the Gasteropoda, but somewhat exceptional." I consider that a close relationship exists between the siphonal folds of the Cephalopod and the "pteropods" of Pteropoda, and, again, between the arms of the former and the arms (bearing suckers in *Pneumodermon*) of the latter; but there appears to be no ground for going further when we compare these parts with those of a Gasteropod than is involved in assigning them all to "the foot," which certainly cannot be given up to the sole equivalence of the yelk-sac, and is not to be limited, as Mr. Brooks would have it, to an unpaired median growth. I do not see the cogency of the arguments put forward by Jhering for regarding the arms of Pteropods and Cephalopods as distinct from foot; and assuredly it is necessary absolutely to reject Grenacher's notion of their identity with the velum, a notion with which every morphologist has at one time or other amused himself; and, lastly, there appears to be no ground capable of statement for regarding, as Brooks would do, the siphon (funnel) as a growth peculiar to the Cephalopod. Its condition in *Nautilus* alone is sufficient to show that it is a part of the molluscan foot.

XLV.—*The Structure and Affinities of* Euphoberia, *Meek and Worthen, a Genus of Carboniferous Myriopoda.* By Samuel H. Scudder*.

The genus *Euphoberia* was established in 1868, for some remarkable spiny Myriopoda found in the ironstone nodules of Mazon Creek, in Illinois, and which were first fully described and figured in the third volume of the Geological Report of the Illinois Survey. The only characteristics then noted, in which they differ from modern types, were the tapering form of the body and the presence of branching

* From the 'American Journal of Science,' March 1881, pp. 182–186.